UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/965,757	09/28/2001	Youfeng Wu	42390P10792	2970

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EXAMINER
FOWLKES, ANDRE R

ART UNIT	PAPER NUMBER
2192	

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Please find below and/or attached an Office communication concerning this application or proceeding.

	Application No.	Applicant(s)
Office Action Summary	09/965,757	WU, YOUFENG
	Examiner	**Art Unit**	
	Andre R. Fowlkes	2192	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE <u>3</u> MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.
- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
  Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on <u>*27 January 2006*</u>.

2a) ☐ This action is **FINAL**.   2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *<u>1-17</u>* is/are pending in the application.

     4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) *<u>1-17</u>* is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.

     Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

     Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

     a) ☐ All   b) ☐ Some * c) ☐ None of:

         1. ☐ Certified copies of the priority documents have been received.

         2. ☐ Certified copies of the priority documents have been received in Application No. _____.

         3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

     * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
     Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413)
     Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1.   This action is in response to the amendment filed 1/27/06.

2.   Claims 1-17 are pending.

Claim Rejections - 35 USC § 103

3.   The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all

obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set
> forth in section 102 of this title, if the differences between the subject matter sought to be patented and
> the prior art are such that the subject matter as a whole would have been obvious at the time the
> invention was made to a person having ordinary skill in the art to which said subject matter pertains.
> Patentability shall not be negatived by the manner in which the invention was made.

4.   Claims 1-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over

Lowry et al. (Lowry), "Object Code Optimization", Communications of the ACM, in view

of Chang et al. (Chang), "Using Profile Information to Assist Classic Code

Optimizations", Software—Practice & Experience, further in view of Bodik, Path-

Sensitive, Value-Flow Optimizations of Programs, University of Pittsburgh PHD Thesis,

5/31/1999.

As per claim 1, Lowry discloses a **system comprising a compiler to generate**

object code from a computer program, a code optimizer to optimize the object

code generated by the compiler (p. 13 col. L:46 - col. R:3, "(the) compiler performs

the most thorough analysis of source code and produces the most efficient (optimized)

object code"), **the code optimizer including:**

   - a first device to formulate regions (p. 14 col. L:17-18, "the program is broken

into computational 'blocks' (i.e. regions)"),

   - a second device to select initial regions from the formulated regions (p. 14

col. L:17-18, "the program is broken into computational 'blocks' (and the regions are

selected)"),

   - a third device to apply code motion (p. 21 col. L:29-30, "Elimination of

unnecessary unconditional braches by reordering the code"),

   - a fifth device to compute UEU(E,R) and DED(X,R), wherein UEU(E,R)

represents a number of upward exposed registers at a main entry E of a region R

that are used in the region R and DED(X,R) represents a number of downward

exposed registers at a main exit X of the region R that are defined in the region R

(p. 20 col. R:20-30, The number of upward exposed registers, UEU(E,R), and the

number of downward exposed registers, DED(X,R), are computed for each command,

and notated as follows: "11—The operand is available in a register and it must be

retained in that register after the operation (i.e. UEU(E, R)), and 00—The operand must

be fetched from storage and retained in a register after the operation (i.e. DED(X,R))"),

   - a memory to store the compiler and the code optimizer, and a central

processing unit (CPU) cooperatively connected to the memory to execute the

compiler and the code optimizer (p. 22 col. R:26-27, "storage (i.e. memory) speed

and ... CPU's").

Lowry doesn't explicitly disclose **a fourth device to apply tail duplication.**
However, Chang, in an analogous environment, discloses **a fourth device to apply tail
duplication** (p. 13:4-5, "More code transformations are applied after tail duplication").

Therefore, it would have been obvious to a person of ordinary skill in the art, at
the time the invention was made, to incorporate the teachings of Chang into the system
of Lowry to apply tail duplication. The modification would have been obvious because
one of ordinary skill in the art would have wanted to use the well-known technique of tail
duplication to further optimize the program code.

The Lowry/Chang combination doesn't explicitly disclose a fourth device to **apply
tail duplication to separate instructions.** However, Bodik, in an analogous
environment, discloses a fourth device to **apply tail duplication to separate
instructions** (p. 13:23-25, "A simple form of restructuring is tail duplication which
separates frequently executed paths to improve scheduling by separating control flow
merge points").

Therefore, it would have been obvious to a person of ordinary skill in the art, at
the time the invention was made, to incorporate the teachings of Bodik into the
Lowry/Chang system to apply tail duplication to separate instructions. The modification
would have been obvious because one of ordinary skill in the art would have wanted to

use the well-known technique of tail duplication to isolate certain instructions to further

optimize the program code.

As per claim 2, the rejection of claim 1 is incorporated and further, Lowry

discloses that **the second device selects initial regions by selecting sub-control**

flow graphs as regions such that the region starts execution mostly at the main

entry and completes mostly at the main exit (p. 14 col. L:15-40, "the program is

broken into computational 'blocks' ... Each block consists of a sequence of statements,

only the first of which may be branched to (i.e. execution starts at the main entry), and

only the last of which contains a branch (i.e. execution completes at the main exit)").

As per claim 3, the rejection of claim 1 is incorporated and further, Lowry

discloses that **the fifth device computes UEU(E,R) and DED(X,R) using local**

information from the region R (p. 20 col. R:20-30, The number of upward exposed

registers, UEU(E,R), and the number of downward exposed registers, DED(X,R), are

computed for each command and notated as follows: "11—The operand is available in a

register and it must be retained in that register after the operation (i.e. UEU(E, R)), and

00—The operand must be fetched from storage and retained in a register after the

operation (i.e. DED(X,R))").

As per claim 4, the rejection of claim 1 is incorporated and further, Lowry

discloses that **the third device applies code motion by moving instructions outside**

the region R into the region R (p. 21 col. L:29-30, "Elimination of unnecessary

unconditional branches by reordering the code (i.e. code motion)", and code motion is

used to move instructions to/from the entry, interior, and/or exit of a region, R).

As per claim 5, the rejection of claim 4 is incorporated and further, Lowry

discloses that **the third device moves instructions outside of the region R into the**

main entry E and the main exit X of the region R (p. 21 col. L:29-30, "Elimination of

unnecessary unconditional branches by reordering the code (i.e. code motion)", and

code motion is used to move instructions to/from the entry, interior, and/or exit of a

region, R).

As per claim 6, the rejection of claim 5 is incorporated and further, Lowry

discloses that **the third device moves instructions outside of the region R into the**

main entry E and the main exit X of the region R, and later moves the instructions

from the main entry E and the main exit X of the region R to other places inside

the region R (p. 21 col. L:29-30, "Elimination of unnecessary unconditional branches by

reordering the code (i.e. code motion)", and code motion is used to move instructions

to/from the entry, interior, and/or exit of a region, R).

As per claim 7, the rejection of claim 1 is incorporated and further, Lowry doesn't

explicitly disclose that **the fourth device applies tail duplication to separate**

reusable instructions executed along a side entry after selection of initial regions.

However, Chang, in an analogous environment, discloses that **the fourth device applies tail duplication to separate instructions executed along a side entry after selection of initial regions** (p. 13:2-3, "we duplicate the tail part of the ... trace (to separate the instructions)").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Chang into the system of Lowry to apply tail duplication to separate the instructions. The modification would have been obvious because one of ordinary skill in the art would have wanted to use the well-known technique of tail duplication to separate the instructions and then further optimize the program code.

As per claim 8, the rejection of claim 1 is incorporated and further, Lowry doesn't explicitly disclose that **the fourth device applies tail duplication during application of code motion.**

However, Chang, in an analogous environment, discloses that **the fourth device applies tail duplication during application of code motion** (p. 13:4-5, "More code transformations (i.e. code motion) are applied after tail duplication").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Chang into the system of Lowry to apply tail duplication during code motion. The modification would have been obvious because one of ordinary skill in the art would have wanted to use the well-known techniques of tail duplication and code motion to further optimize program code.

5.   Claims 9-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over

Lowry et al. (Lowry), "Object Code Optimization", Communications of the ACM, in view

of Chang et al. (Chang), "Using Profile Information to Assist Classic Code

Optimizations", Software—Practice & Experience, in view of Bodik, Path-Sensitive,

Value-Flow Optimizations of Programs, University of Pittsburgh PHD Thesis, 5/31/1999,

further in view of Bharadwaj, U.S. Patent No. 5,787,287.

As per claim 9, Lowry discloses:

- **computing UEU(E,R) and DED(X,R), wherein UEU(E,R) represents a

number of upward exposed registers at a main entry E of a region R that are used

in the region R and DED(X,R) represents a number of downward exposed

registers at a main exit X of the region R that are defined in the region R** (p. 20 col.

R:20-30, The number of upward exposed registers, UEU(E,R), and the number of

downward exposed registers, DED(X,R), are computed for each command, and notated

as follows: "11—The operand is available in a register and it must be retained in that

register after the operation (i.e. UEU(E, R)), and 00—The operand must be fetched from

storage and retained in a register after the operation (i.e. DED(X,R))"),

- **applying code motion** (p. 21 col. L:29-30, "Elimination of unnecessary

unconditional braches by reordering the code"),

Lowry doesn't explicitly disclose **applying tail duplication.** However, Chang, in

an analogous environment, discloses **applying tail duplication** (p. 13:4-5, "More code

transformations are applied after tail duplication").

Therefore, it would have been obvious to a person of ordinary skill in the art, at

the time the invention was made, to incorporate the teachings of Chang into the system

of Lowry and **applying tail duplication**. The modification would have been obvious

because one of ordinary skill in the art would have wanted to use the well-known

technique of tail duplication to further optimize the program code.

The Lowry/Chang combination doesn't explicitly disclose a fourth device to **apply**

tail duplication to separate instructions. However, Bodik, in an analogous

environment, discloses a fourth device to **apply tail duplication to separate**

instructions (p. 13:23-25, "A simple form of restructuring is tail duplication which

separates frequently executed paths to improve scheduling by separating control flow

merge points").

Therefore, it would have been obvious to a person of ordinary skill in the art, at

the time the invention was made, to incorporate the teachings of Bodik into the

Lowry/Chang system to apply tail duplication to separate instructions. The modification

would have been obvious because one of ordinary skill in the art would have wanted to

use the well-known technique of tail duplication to isolate certain instructions to further

optimize the program code.

The Lowery/Chang/Bodik combination doesn't explicitly disclose selecting initial regions **based on completion probabilities.** However, Bharadwaj, in an analogous environment, discloses selecting initial regions **based on completion probabilities** (col. 11:8-16, "Associated with each control flow path is a probability that the particular path will be taken during execution of the program (i.e. a completion probability). It is useful to know how speculative (wasteful) a code motion is (i.e., likelihood of the instruction being executed unnecessarily). This speculativeness is simply the sum of the probabilities of the paths which have their corresponding bits set in the speculation path vector. Using this measure during instruction scheduling, less speculative code motions can be given preference over more speculative code motions.").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Bharadwaj into the Lowry/Chang/Bodik combination and selecting initial regions **based on completion probabilities**. The modification would have been obvious because one of ordinary skill in the art would have wanted to efficiently optimize the program code by applying optimizations to the code most likely to be executed.

As per claims 10-16, this is a method version of the claimed system discussed above, in claims 2-8, wherein all claimed limitations have also been addressed and/or cited as set forth above. For example, see Lowery p. 14 col. L:17- p. 21 col. L:30, Chang, p. 13:4-5 and Bodik, p. 13:23-25.

As per claim 17, this is a machine readable medium version of the claimed

method discussed above, in claim 9, wherein all claimed limitations have also been

addressed and/or cited as set forth above. For example, see Lowery p. 14 col. L:17-

21 col. L:30, Chang p. 13:4-5, Bodik p. 13:23-25 and Bharadwaj col. 11:8-16.

Response to Arguments

6.   Applicant's arguments, at p. 5:18-6:7, with respect to the Mills reference have

been considered but are moot in view of the new ground(s) of rejection.

Conclusion

7.   Any inquiry concerning this communication or earlier communications from the

examiner should be directed to Andre R. Fowlkes whose telephone number is (571)

272-3697. The examiner can normally be reached on Monday - Friday, 8:00am-

4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's

supervisor, Tuan Q. Dam can be reached on (571)272-3695. The fax phone number for

the organization where this application or proceeding is assigned is 571-273-8300.

ANTONY NGUYEN-BA
PRIMARY EXAMINER

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ARF